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TELEMETRY OPERATIONS

IN

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IN

SASKATCHEWAN

by

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ABSTRACT

This report was written by the Data Collection Platform (DCP) Working Group, comprised of C. Brumwell, L. Heinze and D. Turgeon, which was formed by the Regional Chief, WRB Saskatchewan in February 1988 as a result of concerns raised with the DCP program.

The report includes a description of the current DCP network and the need for it, costs associated with the installation, operation and maintenance of the network, issues identified with the various elements of the DCP program, recommendations to correct the issues and a proposed telemetry network for WRB Saskatchewan.

The report identifies a large number of issues and recommendations as a result of a DCP questionnaire and the authors' familiarity with the DCP network. The working group recommends that:

1. A DCP Procedures Manual be developed for WRB Saskatchewan.

2. The purpose for all future DCP installations be clearly defined before installation.

3. A service agreement be negotiated with the Saskatchewan Water Corporation specifying the terms of operation of DCP equipped gauging stations.

4. All DCP installations be electronically grounded.

5. Basic Electronics training be provided to all hydrometric field staff.

6. Factory representatives detail the correct installation, maintenance and testing procedures for all the components of the photovoltaic system.

7. Training be provided to hydrometric staff for all new instrumentation before field installation.

8. Field staff be included in the development of future computer software dealing with the use of digital data.

9. The Regional Chief and Regional Engineer encourage the development of a national system for the exchange of information on all aspects of DCPs.

10. The Saskatchewan telemetry network be reviewed on an annual basis and a supplementary report be prepared.

1 INTRODUCTION

The Regional Chief, WRB Saskatchewan, formed a Data Collection Platform (DCP) Working Group in February 1988 to review the DCP network in Saskatchewan and recommend improvements to the DCP program. The need for improvements to the DCP program was expressed at the September 1987 Saskatchewan WRB Supervisors Meeting. This report is the result of the review completed by the DCP Working Group.

The report contains the following:

- the status of the network on March 31, 1989
- the need for the current network
- cost information on the installation, operation and maintenance of the network and estimated savings
- issues under installation, field servicing and operations, data acquisition, data processing use, quality control, training and management
- recommendations to correct the issues
- a proposed telemetry network including DCPs and other telemetry systems.

The length of time taken by the DCP Working Group is acknowledged as a serious concern by the authors. The dynamic nature of remote sensing technology, the network and data acquisition procedures has posed some difficulty to the authors since every time the report was reviewed, significant changes had occurred in some facet of the program. It is also acknowledged that many steps have already been taken to correct deficiencies in the program.

2 CURRENT NETWORK

2.1 Location and Status of the Network

Table 1 is a listing of the network along with pertinent information such as platform identifier, time slot and other site parameters as of March 31, 1989. Figure 1 is a map of Saskatchewan showing the status (active and inactive) of the telemetry network on March 31, 1989.

2.2 Need for the Current Network

The current network of stations equipped with data collection platforms evolved primarily as a result of the National Five Year Acquisition Plan initiated in 1982 and because of internal and external pressure for more timely water resources data for water management purposes. Summarized below are the known or suspected uses of data for the existing network. Gauging stations in this network with no known telemetry needs are also identified. A recommendation on the requirement for a DCP at each site is made based on the following criteria:

1. Do other agencies require the data? Are we operating the site for another agency - for example Abitau River?

2. Are the data used for water management? flood forecasting?

3. Are the data critical to the operation of a structure, plant, reservoir?

4. What is the relative value of the data? For example, the value of water in a multi-purpose reservoir is far greater than the water in a river with no known uses.

5. Are the data required due to a safety concern?

6. Are the data required for monitoring an agreement?

7. Are the data necessary to fill in missing chart record or is the hydrograph shape predictable?

8. Are the data useful in planning field trips to improve data quality - for example remote sites with undeveloped stage-discharge curves? low water? high water? backwater conditions?

9. Are the data useful in planning field trips to reduce costs - for example can a station be by-passed or a field trip avoided?

10. Can the data be used as a basin indicator of flow conditions?

11. Does the station have a stable, backwater-free control which would allow discharges to be computed directly from the corrected stage?

12. Can the data be used for answering data requests? Are the data requested on a regular or frequent basis?

13. What is the cost of maintaining a DCP at the site? For example, a station with only helicopter access compared to one accessible by car.

14. Is there a requirement for other data at the site. For example, temperature, precipitation, environmental monitoring.

15. Is vandalism a problem?

16. Are there transmission or solar insolation problems due to obstructions which cannot be moved?

2.2.1 Water Survey of Canada Program

Most of the platforms under this program are the old style Bristol platform. Data from these platforms cannot be processed with the WSC software.

05EF004 Battle River near the Saskatchewan

This is a Prairie Provinces Water Board (PPWB) station, therefore there is a continued interest in timely information for this site. Telemetered data are often used to compute flows for the PPWB on a monthly basis. Other users of data for this site include Sask Water, and Alberta Department of the Environment (ADOE), particularly during low flows and the WSC Prince Albert for runoff monitoring and trip planning. This is a Bristol Hydromet.

There is a continued need for a DCP at this site.

05MD004 Assiniboine River at Kamsack

Manitoba Water Resources are the primary user. Telemetered data are used to plan the operation of Shellmouth Reservoir especially during spring runoff. Sask Water uses the DCP data for flood forecasting. The Prairie Farm Rehabilitation Administration (PFRA) have a sporadic interest in data from the site mainly to assess possible backwater effects and flooding because of Shellmouth Reservoir. The Water Survey of Canada makes use of the data for runoff monitoring, trip planning and for flow calculations for PPWB reporting. This is a Bristol Hydromet.

There is a continued need for a DCP at this site.

05NB009 Souris River near Roche Percee

Telemetry equipment was purchased for this site by the U.S. National Weather Service (NWS) and is used for flood forecasting by the NWS and Sask Water. WSC Regina periodically uses the data as an indicator of local runoff, particularly for Short Creek. This is an old style DCP.

There is a continued need for a DCP at this site.

05ND004 Moose Mountain Creek near Oxbow

Moose Mountain Creek is a major tributary of the Souris River and during high flow years, flow information is required to manage Lake Darling in North Dakota. The DCP was purchased by the NWS but is operated by the WSC. Data from this site are used by the NWS and Sask Water for flood forecasting and by the WSC as a runoff indicator and for trip planning. This is an old style DCP.

There is a continued need for a DCP at this site.

11AB009 Middle Creek near the Saskatchewan Boundary

Data are used by WSC Regina for the computation of the 10-day international apportionment, for interprovincial apportionment, as a runoff indicator and for trip planning, and by Sask Water and ADOE as a real time indicator of inflow to Middle Creek Reservoir. A Bristol Hydromet DCP was installed at this site in the fall of 1989.

There is a continued need for a DCP at this site.

11AB027 Battle Creek at the International Boundary

Data from this station are used by WSC Regina for the computation of the 10-day international apportionment and for trip planning, particularly during spring runoff because of access problems to the site. Sask Water may use the data for water management purposes during spring runoff, irrigation season and when releasing water from reservoirs on Battle Creek. A Bristol Hydromet DCP was installed at this site in the fall of 1989.

There is a continued need for a DCP at this site.

11AB082 Lodge Creek near the Alberta Boundary

Data from this station are used mainly by ADOE for water management of Alberta reservoirs and Sask Water to calculate inflow to Altawan Reservoir. The WSC uses the data during spring runoff and as an indicator of rainstorm runoff during the summer and for interprovincial apportionment. A Bristol Hydromet DCP was installed at this site in the fall of 1989.

There is a continued need for a DCP at this site.

11AB089 Altawan Reservoir near Govenlock

Data from this station are used by the WSC for the 10-day international apportionment. Only midnight readings at the end of the period are required. A Bristol Hydromet DCP was installed at this site in the fall of 1989.

There is a continued need for a DCP at this site.

11AB117 Battle Creek at the Alberta Boundary

Data from this station are used by ADOE and Sask Water. WSC requires the data for interprovincial apportionment and for trip planning, particularly during spring runoff, because of the difficult access to the site. A Bristol Hydromet DCP was installed at this site in the fall of 1989.

There is a continued need for a DCP at this site.

2.2.2 Saskatchewan Water Corporation Program

Data from these sites are of limited value to the WSC but are used by Sask Water mainly for water management.

05EF001 North Saskatchewan River near Deer Creek

Data from this station are used by ADOE to monitor low flow effluent dilution and by Sask Water for flood forecasting and to assist in the management of downstream hydroelectric plant reservoirs (Codette and Tobin). Because this is a PPWB station there is continued interest for these data. The WSC uses the data to answer requests from PPWB and other agencies. The platform is an old style DCP.

There is a continued need for a DCP at this site.

05CK004 Red Deer River near Bindloss

The data from this station which is located in Alberta is used by Sask Water for inflow forecasting for Lake Diefenbaker. The data may also be used by WSC Calgary for minimum flow monitoring. The platform is an old style DCP.

There is a continued need for a DCP at this site.

Note: The DCP was removed from this site in 1989 at the request of Sask Water as the telemark at the station was sufficient for their needs.

05HF003 Lake Diefenbaker at Gardiner Dam

Data from this station are used by Sask Water to manage Lake Diefenbaker. The platform is a Bristol Hydromet.

There is a continued need for a DCP at this site.

05JK002 Qu'Appelle River below Craven Dam

This has been used as a convenient test site for various sensors and for water management purposes. This is a Bristol Hydromet.

Sask Water have indicated a continued need for a DCP at this site.

05JM001 Qu'Appelle River near Welby

This is a PPWB station of interest to both Manitoba and Saskatchewan. Manitoba Water Resources Branch (MWRB) uses the data for forecasting cooling water requirements for the Brandon Power Plant which is located near the Assiniboine River.

Data for low flow periods are meaningless without discharge measurements because of changing backwater conditions, but they can be used by the WSC during the spring period as a runoff indicator. This is an old style DCP.

It is likely that MWRB would want the DCP maintained at the site but it is of limited value to the WSC.

It is suggested that a DCP be retained.
Note: The DCP was removed from this site in the summer of 1989 but the DCP was re-installed at the request of Sask Water.

05JM006 Crooked Lake near Grayson

Data are used by Sask Water to manage this recreational lake. The platform is an old style DCP.

There is a continued need for a DCP at this site.

06CD002 Churchill River above Otter Rapids

This station is one of a number of stations on the Churchill River used by Sask Water and the Saskatchewan Power Corporation (SPC) to manage the Island Falls electrical generating station. Periodically the WSC use the data as a runoff indicator and to answer data requests. This site is subject to signal degradation due to the location of the gauging station.

There is a continued need for a DCP at this site.

06DD002 Reindeer River above Devil Rapids

This station is used by Sask Water and SPC to manage the Island Falls electrical generating station and to monitor releases from Reindeer Lake. Winter discharges and unsteady flow periods may be affected by variable backwater effects, therefore there is some question about the quality of calculated flow data.

There is a continued need for a DCP at this site.

06EA010 Churchill River above Maple Leaf Rapids

This station is required by Sask Water and SPC to monitor flows into Manitoba. It is likely that MWRB and Manitoba Hydro also have an interest in this site. The data from this site and from the Wintego Rapids station would likely be requested if litigation over effects from the operation of the Whitesand Dam on Reindeer Lake and the Island Falls electrical generating station occurred. There is a serious question of the accuracy of the flow data for the Maple Leaf site because of the possibility of backwater from Okipwatsikew Lake. SPC indicated in earlier talks that they would prefer monitoring a point further downstream, probably on the lake.

Sask Water and SPC have an interest in retaining a DCP at this site.

06EA011 Churchill River above Wintego Rapids

This station is required by Sask Water and SPC to forecast inflows to the forebay of the Island Falls generating Station.

Sask Water and SPC have an interest in retaining a DCP at this site.

07QC005 Abitau River above Cuming Lake

The station and DCP were installed for SPC to improve inflow forecasts to Tazin Lake. SPC have acquired the generating station formerly used to generate electricity for Eldorado Nuclear and are considering raising Tazin Lake to increase the head and storage.

SPC have an interest in retaining a DCP at this site.

07QC006 Tazin River above Tazin Lake

This station was built and is operated under the same conditions as the Abitau station.

SPC have an interest in retaining a DCP at this site.

2.2.3 WRB National DCP Program

Data collection platforms were installed at the following sites because of accessibility considerations. All the sites are considered "remote" because of the requirement for air access,

therefore cost savings due to better trip scheduling were expected. It was also hoped that a more effective field program could be operated (better curve definition, less record loss) by having information on streamflow and equipment conditions before visiting the sites.

06AG002 Dore River near the Mouth

As described under the Canoe River narrative it is suggested that the DCP be removed from this site because of access and transmission problems.
Note: **The DCP was de-activated October 2, 1989.**

06BA002 Dillon River below Dillon Lake

As described under the Canoe River narrative, it is recommended that the DCP be removed from this site due to vandalism problems.

06BB004 Keeley River at Outlet of Keeley Lake

DCP data for this site are only useful for monitoring equipment operation, and to a limited degree, basin runoff conditions. This site does have the advantage of a backwater-free control and could possibly be used as advance warning of high or low water in the Canoe River.

It is recommended that the DCP be retained for at least two more years but re-evaluated at that time for its usefulness.

06BB005 Canoe River near Beauval

Data from this site can be used in a limited way as an indicator of increased runoff from rains in this part of the province. Weeds in the channel cause varying backwater reducing the value of the data. A DCP located at either the Canoe, Dillon or Dore Rivers could be used to monitor streamflow conditions in the area. The Dillon River is subject to considerable vandalism and the Dore River location has a transmission problem due to the tall trees around the site. There is also an access problem at the Dore because of these trees. Even though the Canoe River is less than ideal it is better suited to a DCP than the other two.

**It is suggested that a DCP be retained at this site.
Note: The DCP was de-activated in the fall of 1989 due to operational difficulties.**

06BC001 Mudjatik River above Forcier Lake

Conditions and requirements for a DCP at this site are the same as for the Haultain. A case could be made for discontinuing one of these two, but because of the need to improve forecasts for the Churchill River and because telemetry of any sort cannot be installed at the Churchill River near Patuanak because of vandalism, it is suggested that the Mudjatik site be continued.

It is recommended that a DCP be retained at this site.

06BD001 Haultain River above Norbert River

DCP data for this site can be used as a basin indicator of the upper Churchill River basin. It is also difficult to predict the shape of the hydrograph if stage record is lost. The Atmospheric Environment Service (AES) have indicated that they would like to install additional sensors at this site.

It is recommended that the DCP be retained at this site.

06CE001 Foster River above Churchill River

DCP data from this site are used to forecast inflow from the middle Churchill basin. The station has the advantage of a stable, backwater-free control. There is also an interest in data for this river by canoeists. The stage-discharge relation requires further highwater refinement and the basin reacts quickly to precipitation.

It is recommended that the DCP be retained at this site.

06DA001 Wollaston Lake at Ross Channel

DCP data from this station are used by Sask Water and SPC as an indication of inflows to Reindeer Lake. The WSC Manitoba also operate a station on the Cochrane River. A few readings a day would be sufficient on this large lake. There is extensive uranium mining development adjacent to and west of Wollaston Lake.

It is suggested that the DCP be retained until further discussions are held with Sask Water and SPC.

06DA004 Geikie River below Wheeler River

Data from this site can be used as an indicator of runoff in this area of the province and as an indicator of inflow to Wollaston Lake. The stage-discharge curve is well defined and very seldom is affected by backwater from ice. There is a choice between operating a DCP at this site or at the Wheeler River.

It is recommended that a DCP be retained at this site.

06DA005 Wheeler River below Russell Lake

DCP data from this site serves little purpose other than for monitoring equipment problems (as likely as not we would see a problem with the DCP before the servo-manometer).

It is recommended that the DCP be removed from this site.
Note: The DCP was removed from this site in the fall of 1989.

06DB003 Thymehill River below Mackenzie Lake

In addition to trip planning, the data can be used as an indicator of inflow to Reindeer Lake. Because the stage-discharge curve is well developed, there is little added benefit for special measurement scheduling.

Because of the good control conditions (except for high water), discharge data can be computed with a good degree of confidence, and because there are no other stations in this area, **it is suggested that the DCP be retained and re-evaluated in two years.**

06DC001 Wathaman River below Wathaman Lake

Sask Water and SPC have an interest in this site because it is one of the major contributors to Reindeer Lake. This site has also been used as a test site by the AES. Several sensors have been operated at the site with varying degrees of success. Operation of the sensors may have caused loss of water level data because of the electrical drain on the batteries. The operation of sensors have also required significant extra effort by both AES and WSC. The station is presently operated without the meteorological sensors.

The stage-discharge curve has been well-defined in recent years therefore the data would be of limited value for defining the curve.

Because discharge data can be computed with a good degree of confidence **it is recommended that the DCP be retained without the AES sensors** to decrease servicing time.

06EA002 Churchill River at Sandy Bay

There is a moderate to high degree of interest by several agencies (Sask Water, SPC, WSC) for DCP data from this site. The station has the advantage of a backwater-free control but the disadvantage of being highly regulated. Equipment operation could be monitored by a local resident and flow conditions could be obtained from the Island Falls generating station. Nevertheless, the data have proven useful for answering requests and planning trips to cover low or high flow conditions. The possibility of changes to the dam and generating station may make the data more useful.

It is suggested that the DCP be retained at this site.

06EA007 Pagato River at Outlet of Pagato Lake

This station is located on a small tributary of the Churchill River near the Manitoba border. DCP data are of limited value to Saskatchewan agencies.

It is recommended that the DCP be removed from this site.
Note: MWRB have indicated an interest in data from this site.

07CD006 Clearwater River at Outlet of Lloyd Lake

DCP data for this site are used as a basin indicator and are also requested frequently by canoeists. The stage-discharge relation is well defined and free of ice and any other effects year round. This river has been designated as a National Heritage river.

It is recommended that a DCP be retained at this site.

07CD007 Descharme River below Dupre Lake

This site is sometimes subjected to vandalism. Real time data has little value for this basin. The stage-discharge relation is affected by weeds during the summer and some ice in the winter.

It is suggested that the DCP be removed from this site.
Note: The DCP was de-activated in the fall of 1989.

07LB002 Waterfound River below Theriau Lake

This station is located on the river which drains Waterbury Lake, an area subject to expanding uranium mining. The stage-discharge relation is stable and ice-free but could benefit from further refinement in the high flow range. The hydrograph is very predictable and slow to react to basin conditions due to the large proportion of lake storage.

It is suggested that the DCP be removed from this site.
Note: The DCP was de-activated in 1990.

07LC002 Chipman River above Black Lake

The Chipman and Porcupine Rivers both flow out of Selwyn Lake, therefore making it easier to estimate missing data or predict flow conditions for one site if the other is monitored. The Porcupine site is preferable for telemetry because of better transmission conditions. The Chipman site is also close to Stony Rapids, therefore it is unlikely that a station visit would be skipped even if the equipment was operating successfully.

It is recommended that the DCP be removed from this site, but Sask Water and SPC should be informed of this decision.
Note: The DCP was de-activated in the fall of 1989.

07LC003 Porcupine River at Outlet of Grove Lake

DCP data from this site could be used as a basin indicator of runoff into Black Lake on the Fond-du-Lac system. The station has a backwater free control.

It is recommended that the DCP be retained at this site.

07LD001 Cree Lake at Cable Bay

A DCP at this site is only of use for monitoring equipment conditions. The same function could be served by having the AES technicians look at the equipment periodically. Lake levels on such a large lake are only subject to a slow predictable change, therefore the DCP would not improve estimates of water levels if chart record was lost due to equipment failure.

It is recommended that the DCP be removed from this site.

07LD002 Cree River at Outlet of Wapata Lake

The Cree River is a major tributary of the Fond-du-Lac River and provides an indication of streamflow conditions over a large area not monitored by other stations. The only significant on-channel storage is Cree Lake which often stores water during the winter period and releases it early in the spring. The stage-discharge relation also requires further refinement at the high end.

It is recommended that the DCP be retained at this site.

07LD003 Pipestone River below Rotariu Lake

The station is located on a tributary of the Cree River. Large trees in the vicinity of the gauge cause transmission problems. DCP data are of limited value at this site.

It is recommended that the DCP be removed from this site.
Note: The DCP was de-activated in the fall of 1989.

07LE002 Fond-du-Lac River at Outlet of Black Lake

The Fond-du-Lac River is the major source of inflow to Lake Athabasca and is important for this reason alone. The stage-discharge relation for the station is stable, ice free, and well defined. The data can be used as a major indicator of streamflow conditions over a large area of the north. Vandalism is a continuing problem at this site and may be the predominant reason for removing the DCP.

It is recommended that an attempt be made to continue to operate the DCP at this site, but that it be removed if vandalism increases.

07LE003 Grease River below Fontaine Lake

DCP data from this site would be mainly used as a basin indicator, particularly if the DCP was removed from the Chipman station. It could also be used to schedule a high water measurement trip to the site since there is still a requirement to define the stage-discharge curve at the top end. The station normally has a backwater free control. There is a low to moderate requirement for a DCP at this site therefore it is recommended that the decision to retain it be re-evaluated annually.

It is recommended that the DCP be retained at this site, but the need re-evaluated annually.

07LE004 Otherside River at Outlet of Mercredi Lake

The requirement for data from this site is not high if DCPs are operated at the Macfarlane and Cree River stations. The station has a reasonably well defined stage-discharge relationship which is essentially ice free. The high flow range does, however, require further definition. If it is decided to remove the DCP from the Fond-du-Lac site this DCP should be retained until the high water portion of the curve is defined.

It is recommended that the DCP be removed from this site.
Note: The DCP was de-activated at this site in the fall of 1989.

07MA003 Douglas River near Cluff Lake

DCP data serves little purpose at present other than for monitoring equipment condition, however there is a uranium mine in the basin. It is recommended that the DCP not be removed at this time due to the possibility of monitoring other parameters.

It is recommended that the DCP be retained but the usefulness of the data be reviewed in two years.

07MA004 William River above Carswell River

This river is unique in that there is very little on-channel storage, resulting in extensive backwater caused by ice and slush in the channel. The shape of the hydrograph is also unpredictable due to the lack of storage. The winter period and spring breakup are difficult to compute because of the changing backwater. A simple sensor which could detect ice-out and another which would monitor water and/or air temperature would aid in interpreting the record.

It is recommended that the DCP be retained at this site and additional sensors be added.

07MB001 Macfarlane River below Davy Lake

This is a long term station which is located on a major tributary of Lake Athabasca. The station has a well defined stage-discharge relation and a backwater free control.

It is recommended that the DCP be retained at this site.

07MC003 Lake Athabasca at Crackingstone Point

DCP data from this site could be used in forecasts for the Slave River. There is continued interest in flow and water level conditions for the Peace - Athabasca Delta at the west end of the lake. Any apportionment agreement between Alberta, Saskatchewan and the NWT would require data on lake levels.

It is recommended that the DCP be retained at this site.

07QC002 Tazin Lake near the Outlet

DCP data for this site are used by Sask Water and SPC because of hydroelectric generation on the Charlot River. Northern Canada Power Commission (NCPC) also have requested data in the past. There will be an increase in the demand for real time data for this site as Sask Power now operates the hydroelectric station. The Tazin basin also crosses the NWT - Saskatchewan boundary. A few readings a day would be sufficient.

It is recommended that the DCP be retained at this site.

2.2.4 Stations Equipped with Telemarks

Telemetry needs prior to the introduction of the DCP were accomplished either by hiring an observer or by installing a Telemark which could be interrogated by telephone. A number of the Telemark-equipped sites are still in existence but should be re-evaluated so that equipment and data processing procedures can be standardized. The clientele accessing the Telemarks must be considered since many of them do not have ready access to the DCP data. Eventually, however, the equipment must be upgraded.

Spare parts for the Telemark and the Code-A-Phones are difficult to obtain. One alternative is to purchase the newer generation of Telemark. This has drawbacks: a) it introduces one more piece of equipment a technician must service (we should be standardizing on fewer instruments); b) it is an expenditure of capital dollars when there are already spare DCPs available; c) the data from the telemark requires special programs for access and computation. Disadvantages of the DCP system are that it is more time consuming to maintain and manage and access is only available to the user through the regional office, the receive sites or the National Environmental Satellite Data and Information Service (NESDIS) in the United States.

In most cases it is suggested that existing Telemark equipment be operated until it fails, then replaced with a DCP. An exception is the South Saskatchewan River at Saskatoon which should have a DCP installed in 1989-90 coincident with the replacement of the station. It may be useful to retain the Telemark here since the station may be viewed by the public because of the proximity to the National Hydrology Research Institute.

The following are sites equipped with Telemarks:

05GG001 North Saskatchewan River at Prince Albert

This Telemark is frequently accessed by Sask Water, the City of Prince Albert and the WSC. It is suggested that this Telemark be replaced with a Bristol Hydromet DCP. Weyerhauser Pulp Mill have indicated that they require data from this site.
Note: A Bristol Hydromet DCP was installed on October 23, 1989, and the Telemark was retained on-site.

05HG001 South Saskatchewan River at Saskatoon

This Telemark is accessed frequently by Sask Water, the City of Saskatoon and the WSC. It is suggested that the Telemark be replaced with a Bristol Hydromet DCP. The gauging station was re-built and a stilling well was installed in the fall of 1989.

05JF001 Qu'Appelle River at Lumsden

This Telemark is accessed by Sask Water and by the WSC. This is an important telemetry site during flood conditions. It is suggested that the Telemark be replaced with a Bristol Hydromet DCP.
Note: This site was used in 1990-91 to test new DCP equipment.

05JF008 Fahlman Creek near Davin

This station is required for flood forecasting for Wascana Creek mainly during high flow years. The Telemark and phone system are owned by Sask Water but operated by the WSC.

05JF012 Wascana Creek below Kronau Marsh

The situation is the same as at Fahlman Creek.

05JF015 Wascana Lake at Marina

A Telemark, data logger and DCP were installed as part of a demonstration gauging station. Sask Water used the data during spring runoff and to monitor water levels during a couple of summer storms. When the station was moved out of the enclosure on the main floor of the Marina to the basement, the DCP, Telemark and data logger were not re-installed.

It is suggested that no telemetry equipment be re-installed unless requested by Sask Water.

05KD004 Tobin Lake at Squaw Rapids Spillway

SPC may be operating a telemark at this site.

11AB083 Lodge Creek below McRae Creek at the International Boundary

Telemark data are retrieved by Sask Water, WSC, PFRA and the United States Geological Survey (USGS). It is suggested that a DCP be installed but the telemark left in place until it fails or there is a low demand for this service. Sask Water now receive DCP data each day, therefore PFRA could obtain the data from Sask Water's Swift Current office.

11AC041 Frenchman River at the International Boundary

The situation is the same as for the Lodge Creek station.

3 COSTS AND BENEFITS OF THE PROGRAM

The costs of installing and servicing a DCP at a remote gauging station are significantly higher than for a conventional station. The high cost of operating in remote areas is because transportation is via chartered aircraft. A summary of installation and operation costs is provided in Table 2.

3.1 National Program

The majority of remote gauging stations in Saskatchewan have National Program DCPs. The exceptions are five gauging stations which were built for Sask Water and SPC and the Bristol Hydromet DCPs were purchased by Sask Water.

Remote gauging stations require the use of charter aircraft for access. The size and weight of the DCP components, tools and the time required to complete the installation made it impossible to include the installations as part of a regular coverage trip. DCP installation trips were made to install 7 or 8 DCPs over the course of a week. The DCPs were all bench tested in Prince Albert before being packaged and shipped north in preparation for the installation trip.

There were four installation trips; one each in 1984 and 1985 and two in 1986, to install a total of 30 DCPs. Three trips were made using a helicopter (1984, 1985, 1986-1) and one using a Twin Otter (1986-2). The use of the Twin Otter allowed the technicians to carry all the DCPs and tools with them, thus, eliminating the need to ship the DCPs in advance. The use of the Twin Otter meant access was not always right at the station requiring the use of a boat to transport the DCP from the aircraft to the station.

The following table shows a comparison of the four installation trips:

TABLE 2

Saskatchewan
Remote DCP Installation Costs 1984-86

Year		1984	1985	1986-1	1986-2	Average per DCP	Totals
Number of DCPs		8	7	8	7		30
Man hrs testing & preparation	Total	75.2	66.5	83.0	48.3		273
	Unit	9.4	9.5	10.3	6.9	9.0 hrs	
Man hrs field installation	Total	128.8	128.8	124.0	102.2		484
	Unit	16.1	18.4	15.5	14.6	15.9 hrs	
Air charter costs	Total	$9934.00	$7990.00	$6250.00			
	Unit	$1166.00	$1037.00	$893.00	$1062.00	$1062.00	$3184.00
Field Expenses		$438.00	$370.00	$585.00	$700.00	$70.00	$2093.00

The known costs of the DCP Network operated in northern Saskatchewan are approximately $400,000. This includes all the costs associated with the 30 National Program DCPs and the operational costs of four DCPs operated for Sask Water and SPC on the Churchill River basin.

The cost of the DCP units (including antennae) installed as part of the National DCP Program were not charged against the WRB Saskatchewan budget, but the cost of the Memomarks, solar panels, batteries, masts, etc. and the charter cost were all direct costs to regional funds. As well, the A-Base O & M funds were reduced by $1000 for each National Program DCP installed.

NORTHERN DCP NETWORK COSTS:

30 DCPs at $6000. ea	$180 000.
30 Memomarks, solar panels, batteries, etc. at $2700. ea	$81 000.
Installation and operational costs for the period 1983-88	$89 400.
Bristol training - 8 technicians	$7 000.
Total	$357 400.
Loss to A-base O & M budget	$30 000.

The costs are not all monetary, since data recovery and field staff time should be considered. There has been record loss due to:

- the pulse generator drive gear binding
- the clock sensor stopping the takeup spool on the recorder
- the battery voltage dropping so low that the servo manometer would not work

The savings/benefits gathered from the National DCP Program are hard to quantify. The northern network is only serviced five times per year which does not allow for a large reduction in coverage trips. Savings/benefits that have been identified are:

1. During the winters of 1985 and 1986 the December coverage was completed in one week rather than the normal two weeks because the stations with DCPs were working well and were, therefore, over flown. Two weeks of flying costs were saved, resulting in an approximate saving of $25 000.

2. The DCPs have alerted WRB staff to high water events and one additional high water trip was made.

3. The DCPs assisted in planning a low water measurement trip in March 1988.

4. A number of periods of missing chart record have been completed using DCP readings. Periods of missing record can be significant due to the infrequent coverage. It is very hard to attach a dollar value to a day of stage record.

5. The DCP network has reduced the response time for some data requests because the data were available from the DCP.

3.2 Water Survey of Canada Program

The DCPs installed at conventional stations were installed either as a part of a regular coverage trip or on a special trip. The costs of transportation, shipping etc. were minimal, with the major expense being the costs of the DCP, Memomark, etc. There are nine Water Survey of Canada DCPs located at conventional stations.

The cost savings are easier to calculate for the conventional stations because these sites were selected to improve operational efficiency. The savings are mainly time savings; three DCPs located at Altawan Reservoir, Battle and Middle Creeks save two one-and-half day field trips per month during irrigation periods. The DCP readings are used for apportionment computation during irrigation. This saves approximately 16 man-days of field time plus associated field travel expenses per season. As well, three man-days of field time are saved during the freshet period using the DCP readings to monitor the area. The time savings for the other six DCPs are hard to quantify, but they were all installed for specific reasons.

INSTALLATION COSTS

WATER SURVEY OF CANADA PROGRAM - CONVENTIONAL SITES

9 DCPs at $6000.	$54 000.
9 Memomarks, batteries, etc.	$24 300.
Training Regina staff	$ 7 000.
	$85 300.

3.3 Saskatchewan Water Corporation Program

There are twelve Sask Water DCPs in the Saskatchewan network. The DCP components were purchased by Sask Water and installed at conventional sites with little extra cost or at remote sites as a part of the original construction costs. The cost factor in operating a Sask Water DCP is due to unscheduled service trips to these stations. **There is a need for a service agreement between WRB and Sask Water setting out the terms of operation of these DCPs.**

4 ISSUES

The entire DCP program, from installation to management of the program is discussed in this section. In particular, problems experienced during the past ten or so years are identified in the hope that many of these could be avoided and corrected in future years.

4.1 Installation

4.1.1 Procedures Manual

There was, and is, a need for a comprehensive DCP Procedures Manual providing:

- technical information on the components
- specifics of the cabling, mounting brackets, and recommended positioning of the components in/on shelters
- details on the solar panel and regulator
- details on the batteries, charging requirements and testing
- antenna aiming instructions
- detailed instructions for completing the DCP installations

(While the preparation of a comprehensive manual would have required extra time at the start of the program, it would have saved every region considerable time over the last six years. The manual should have been updated each year at the DCP contract review meetings.)

4.1.2 Technical Information Sheets

There is a need for a system of technical information sheets to keep the field staff informed of new problems, solutions and new technology. (One possible method of circulating this information is to include the sheets in the month-end reports which are circulated nationally.)

4.1.3 Input to the Program

The Saskatchewan field technicians identified a number of areas of concern with the National DCP Program. These concerns were communicated to HQ by the Regional Chief. A number of the concerns identified have not been resolved, or are only now being resolved (solar charging, data availability, software and data storage).

4.1.4 Recorder Modifications

- The Stevens A-35 recorder requires modification (grinding of filet on frame) before the pulse generator can be installed.

- The Stevens A-35 recorder requires the installation of a longer float pulley shaft to allow adequate space to handle the pulse generator drive gear, the manometer drive gear and allow for the proper installation of the float pulley clamp assembly and nut. The modification is available from Stevens but it was not recommended or included as a cost in the DCP Program and has not been completed in Saskatchewan.

4.1.5 Size and Weight Considerations

The size and weight of a complete DCP package for installation is such that extra costs are incurred to position and install the units at remote locations.

4.1.6 Solar Panel Installation

The staff were not trained or provided with good technical or installation instructions for the Solar panels and batteries. There should have been a standardized installation list from HQ.

4.1.7 Delivery Date

The National Remote Program DCPs were delivered late in the fall, so they could not be installed until the next year. Then in one year, two years' allotment were received and installed. The installation trips were on top of all the regular work assignments.

4.1.8 DCP Logs

A workable DCP log to record the installation, maintenance and servicing of each DCP should have been developed. A system was put in place, but was not functional and therefore was not maintained.

The requirement for a functional system still remains.

4.1.9 Pre-Testing

Shop testing of each component of a DCP installation before field installation is a time consuming part of a DCP installation, but was not considered in the development of the program.

The cumbersome data retrieval system during the early stages of the National DCP Program added to the pre-testing time as test data was difficult to access to confirm the shop test was successful.

4.1.10 Time Constraints

The installation of a large number of DCPs was added to the regular responsibilities of the region with no serious considerations to the time committment and costs that would be required of the staff involved. There has not been an offsetting saving of time in other areas to compensate for these new activities.

4.1.11 Electrical Considerations

The recommended batteries, a pair of Varta P125 6 volt batteries, are very heavy (70 kg per set). The weight of the batteries made the batteries difficult to move and maneuver in cramped gauging shelters.

The weight of the two batteries in the shipping container is a safety concern. The two batteries should be separated to ease positioning in cramped shelters.

4.1.12 Antenna Masts

A simple mast system is required that meets a number of requirements:

- strong
- lightweight
- easy to install
- protection for cabling
- suitable for mounting both the antenna and solar panel

4.1.13 Bulk Purchasing

Cost savings could have been realized by buying a number of the other components in a National bulk buy; for example:

- masts
- cabling
- lightning protection
- mounting brackets
- appropriate meters for testing signal strength

4.1.14 Vandalism

DCPs cannot be installed in areas of high vandalism due to the exposed antenna and solar panel which may be either stolen or shot up by locals.

4.2 Field Servicing and Operation

4.2.1 Photovoltaic System

The photovoltaic system has caused a number of problems resulting in DCP transmission loss and data record loss.

The problems included:

- trouble with voltage regulators
- some difficulty interpretating installation instructions for voltage regulators
- problems with battery capacity
- a lack of understanding of how the whole system works with very limited resource information.

4.2.2 Procedures Manual

The procedures manual first identified in section 4.1.1 should be a comprehensive manual with sections detailing regular service requirements and detailed trouble shooting information.

A national system of technical bulletins is needed to distribute DCP field servicing and maintenance information to field staff.

4.2.3 Transmission Verification

There is a requirement in the field to know whether a serviced DCP has transmitted. If either the DCP fuse or the transmitter fuse has blown, there is no way of confirming the fact except that the DCP does not transmit. A number of times field crews travelled out of the area of

a reactivated DCP before finding out whether a DCP was transmitting. This can mean a long period before the DCP is reactivated, especially for remote locations where there are only five trips per year.

It is recommended that a frequency counter be carried on all remote coverage trips.

4.2.4 Technical Confidence

The technician's confidence and familiarity in troubleshooting problems with DCPs may be low when gauging stations are only visited five or six times per year. A number of possibilities have to be explored to isolate and correct a problem, therefore, equipment familiarity is important.

4.2.5 Size and Weight Consideration

The size and weight of the DCP installation components prevent their inclusion as part of the regular field equipment on regular coverage trips. Spares have to be positioned in the general area of the station before trips, adding cost for freight and flying to ferry the spares to the sites.

4.2.6 Hand Held Terminals

The number of Hand Held Terminal (HHT) units was, in the early stages, restricted because of the development of the next generation of field programming units and their imminent release for field use. The replacement for the HHT units has not been developed yet. Optimistic time frames can greatly affect field operations.

4.2.7 Remote Terminal Boards

Trouble-shooting erroneous sensor readings on the remote terminal board is a time consuming process. It was not until 1987 that any training in the procedure was provided. This trouble-shooting can easily extend regular coverage trips by a day. One additional day of flying costs approximately $3000.

4.2.8 Memomark Readings

"As found" and "as set" Memomark readings must be recorded for every station visit. Field notes were not designed with DCPs in mind. Memomark corrections must be easily identified if the digital stage data are to be used in the computation of final data.

4.2.9 Field Service Contract

A service contract with the Saskatchewan Water Corporation is required so field staff have specific guidelines to follow regarding special trips to service DCP sites operated for other agencies.

4.2.10 Battery Maintenance

Industry representatives should prepare a set of guidelines for field technicians.

4.2.11 Time Determination

Good quality digital watches for use by field staff are required for programming DCPs in the field. Cheaper watches require frequent resetting and lose time quickly during cold weather. The ultimate solution would be the retrieval of the time from the satellite with a portable receiver.

4.2.12 Other Sensors

Training on servicing AES sensors has not been provided to the field staff. The experience with the AES modification to DCPs to record pressure data created many problems until it was learned that the modification of the pressure sensor caused power to be drawn on a continuous basis. This has resulted in loss of stage data due to low battery voltage.

4.2.13 Time Slot

There is difficulty in notifying another DCP operator if a DCP was accidently set in a wrong time slot.

4.2.14 Power Consumption

There has been no documented method of checking actual power consumption.

4.2.15 Grounding

The need for grounding of the DCP antennas and the effects of lightning storms on the DCP transmitter fuse.

4.2.16 Fixed Frequency vs Frequency Agile Transmitters

It was thought that one DCP could easily be moved from a site where DCP operation has been discontinued to replace a malfunctioning DCP unit somewhere else. While it may be easy to transport and install the DCP unit consideration must be given to whether the replacement unit has a fixed or frequency agile transmitter.

If the DCP has a fixed frequency transmitter it is only capable of transmitting on one channel (i.e. 19) as it can only be used to replace another channel 19 DCP or a significant amount of paper work is required to change the DRGS Master Configuration File, the Platform Data file at NESS as well as all the regional WRB files used in DCP data management.

It is recommended that the DCP instrumentation from sites where DCP operation has been discontinued be returned to the central stores facilities of WRB Regina or Prince Albert for the appropriate service, and testing in preparation for re-installation.

Note: The first frequency agile DCP received by WRB Saskatchewan had serial number BA-EN-450.

The estimates cost to have a fixed frequency transmitter replaced with a frequency agile transmitter by Valcom is $2600 plus software and installation charges.

4.3 Data Acquisition

The quantity of data successfully retrieved from a data collection platform is dependent on many factors: performance of the platform and associated equipment, peformance of the satellites, performance of the receive sites and performance of the network links between headquarters, the receive sites and the regional offices. During the past few years we have seen problems in each of these components resulting in significant losses of data.

4.3.1 Problems

a) Platform and Associated Equipment
- programming errors
- antenna and lead failures
- Memomark failures
- sensor problems
- cabling problems
- transmitter frequency drift
- power problems
- platform failures

b) Satellites
- low satellite power has resulted in a change of satellite position and resulting loss of signal
- deliberate repositioning of satellites
- atmospheric conditions such as high sunspot activity

c) Receive Sites
- incorrect platform information
- incorrect aiming of the antenna
- lack of backup staff for data retrieval
- lack of tracking capability at WRB receive sites.

d) Network Links
- network down at time of data acquisition
- new operating system on PDP 11/44 did not allow communication with receive sites for some time
- local batch retrieval routines were inconsistent
- uncertainty regarding network changes.

Locally, the only areas which can be influenced are problems at the platform site, the network link between the regional office and headquarters and the local batch retrieval routines. Technicians are encouraged to trouble-shoot and resolve known platform problems (easier said than done when dealing with remote sites).

The performance of the network (except for weekends) was reasonably reliable until the attempt to implement the new operating system on the PDP 11/44. Connections could not be established between the receive sites and the PDP systems with the new operating systems. The old operating system (Version 3.0) was reloaded so that the network link could be maintained.
Note: This problem has since been resolved.

4.3.2 Local Retrieval Procedures

The present retrieval system works as follows:

a) At 0700 CST a batch routine is initiated at each receive site. The routine sends data and DCP parameters from 0000 hr to the latest transmission to the Regina PDP 11/44. A batch job in Regina attaches headers, remarks about specific stations and the signal parameters to the file. The procedure then checks for platforms not transmitting data and then prints the computer listing. This listing is used to monitor current conditions and manage the DCP network.

b) At 0715 CST a batch job is initiated on the Regina PDP 11/44 computer. This job checks for a new version of the daily DCP file on the Ottawa computer and copies it to Regina if found. Headers are attached to the station data, a file is created containing only Prince Albert platforms and data for 5 platforms used for international apportionment are printed in Regina.
Note: This procedure has been discontinued.

c) Master files are retrieved on an as needed basis but since reliable processing programs are not available, this is done infrequently.

4.4 Data Processing and Use

a) Computer software has not been developed for processing and using digital data. The limited software that is available did not come with any documentation for the users and is not very useful to the field technicians.

b) The two main options that are available under the @WSC Digital Menu, "Print or View Diagnostics Report" and "Create Stream Input file" were not written to allow for conversion of the raw data files from GMT to the applicable time zone so the printout of daily

mean stage values is incorrect. There is a requirement to allow technicians to quickly screen the raw DCP data for obvious erroneous data.

c) The current @WSC option "Create Stream Input file" creates stream decks of four day periods. Each one of these stream decks must have the "1" and "9" codes adjusted to account for the time zone conversion and to adjust the stage values to account for the memomark correction. This procedure is very cumbersome and time consuming so we have now resorted to hand plotting the readings on a chart and digitizing the hand plotted chart.
Note: A revised DCP program which converts DCP data to the local time zone was obtained from WSC Winnipeg in December, 1989. This option is not available for the DCP page routine or on the VAX computers.
It is inconceivable that this routine is not available at <u>all</u> the WRB offices.

d) The DCP data is not available on a reliable basis in an easily readable format for use by the Regional Engineer, supervisors or field technicians operating a DCP network.

e) The Hydrometric Methods Section of the Water Survey of Canada Ottawa hired a computer programmer to develop software for use in monitoring a DCP network, but the software requires graphic terminals and colour graphic printers which are not available in field offices. The software was developed totally in isolation from the @WSC software so the two programs do not produce compatible output files. The software is difficult to use without a technical knowledge of programming and graphics terminals.

f) The data produced from a large DCP network requires a great deal of storage capacity, adding expense to computer acquisition costs. Our present use of DCP data does not require 24 readings per day, as WSC-Regina are not using the data to compute daily discharges on a regular basis. In most cases one stage reading per transmission would be adequate for our needs. This is certainly not the case, however, if this is the only data being collected.

g) There has been no software development for the MicroVax II. Sub-offices cannot easily

bring down DCP data from HQ or the receive sites to manage the files on these systems.

h) Data files often have extraneous readings.

i) Data users who access the raw data must be aware that the raw data have a number of potential errors and must use the data accordingly.

j) There is no means of bringing down a subset of the Master DCP file (.MST). Often short periods are required but the entire file must be retrieved. An alternative would be to create the .MST files regionally.

k) There should be an identifier that could be keyed in at a station to advise data users that the gauge has been serviced.

l) The final six hours of readings of a year are not easily accessible as they are stored on the following years .MST DCP file.

4.5 Quality Control

The following items have been identified as being necessary to ensure quality control of data acquisition and data processing of DCP data:

a) All equipment should be bench-tested to ensure that it is functional before installation in the field.

b) Logs and inventories should be maintained in order to keep information on the equipment current. The recently designed "DCP Failure Report" sheet may be beneficial as part of this log.

c) The retrieval success rate of an installation should be monitored on a regular and continuing basis in order to determine what the demand/benefit is i.e. the success, the need, the cost.

d) Controls on software are required to ensure that "glitches" are not included in the transmission of raw data.

e) Documentation of manual readings is required to ensure that DCP data are correct, and a tolerance factor for manometer driven, float-activated, and Memomark - acquired data is also required.

f) Top quality digital watches are necessary to ensure accurate setting of time when programming a DCP.

g) Programming from remote sites should be streamlined in order to confirm that the correct data are being transmitted and received, especially after repairs have been made. This would enable the field man to reset/reprogram the system, if necessary, while still at the site.

h) A more user-friendly format should be developed for data being received i.e. time zone corrections applied, Memomark corrections, etc.

i) Users (Sask Water, etc.) should be made aware of the status of the data, whether the data is "raw" or whether time corrections, Memomark corrections, etc. have been applied.

j) It is recommended that an analysis of DCP Failure Reports be undertaken once per year in order to identify problem areas common to most DCP failures. This may serve to isolate common defects in a particular model of the units which may then be rectified by the manufacturer. This yearly analysis should be done by one individual in order to obtain an optimum overview.

4.6 Training

4.6.1 Training Completed

Early in the introduction of the DCP Program, it was recognized that all field technicians would require basic training. The training received to date was as follows:

- July 7, 8, 9, 1981 - First course in Bristol DCPs held in Winnipeg by Bristol Aerospace.
- August 11, 12, 1981 - Second course in Bristol DCPs held in Winnipeg by Bristol Aerospace.
- September 8, 9, 10, 1982 - DCP Workshop held in Regina, and presented by WRB personnel.
- October 20, 21, 1982 - Third course in Bristol DCPs held in Winnipeg by Bristol Aerospace.
- February 9, 1984 - DCP course on the new Hydromet DCP, held in Regina and conducted by R. Terzi (WRB Ottawa) and B. Swail of Bristol Aerospace.
- August 24, 25, 1987 - DCP "Hands-on" Training

course covering field trouble shooting of equipment, in Prince Albert for Prince Albert technicians conducted by R. Terzi, WRB, Ottawa and D. MacNab of Bristol Aerospace.

- Additional training related to the operation and maintenance of DCP related equipment has been given on a "hit and miss" basis.

It is evident that additional training will be required as new equipment is introduced.

4.6.2 Training Requirements

The following future training requirements have been identified:

a) Training in the basic introduction to DCPs, antenna aiming, solar power sources, Memomarks, etc. All field technicians should have this basic training. This may be accomplished by training sessions conducted an as-needed basis, as in the past, or may be developed as a Career Development Program (CDP) lesson package.
Estimated time - 2 days

b) Test bench training, including DCP and related equipment set-up, programming, etc. should be done by technicians once a year. This may be accomplished on a one-on-one basis, in which a technician who is familiar with the equipment, retrains an inexperienced technician.
Estimated time - 1/2 day

c) On-going (refresher) training for technicians who operate DCPs; for example, after a technician has operated a DCP for one year, then a detailed practical hands-on, trouble-shooting session would be beneficial.
Estimated time - 1 day

d) Basic electronics training is required with emphasis on trouble-shooting all equipment. The extent or intensity of such a course is open for debate, but certainly a short course in electrical circuitry and the use of a volt/ohm meter would be beneficial.
Estimated time - 1 day

e) Training in preventative maintenance would be beneficial. This would include maintenance of antennae, batteries, solar panels. Representatives from equipment suppliers (Lenbrook, Varta, Solarex, Synergetics, etc.) should be asked to participate in conducting the course. It is preferable that all training originate at the national level for consistency. This could be in the form of a CDP lesson package, or by a person who is up to date on all aspects of DCP operation.
Estimated time - 1 day

f) Training in data acquisition and data processing is required.
Estimated time - 1/2 day

g) Training in maintenance of platform directory files on the mini computer system.
Estimated time - 2 days

4.6.3 Training Recommended

The following training is recommended:

a) Training in preventative maintenance of antennas, batteries, solar panels, etc. This could also include trouble-shooting equipment in order to isolate problems. This training would be beneficial to all field technicians (1 to 1 1/2 days).

b) Training in the use of SUTRON Software. In order to obtain optimum benefits, the people attending the course should be "computer orientated" (1 to 2 weeks).
Note: This is no longer required.

c) In the event that the Saskatchewan District is forced to abandon the use of the old style DCPs, a 1 day in-house refresher course on the newer Bristol Hydromet DCP would be beneficial (1 day).

d) Training in operation and maintenance of AES Sensors will be necessary, if a site is identified for the Saskatchewan District (1 to 2 days).

4.7 Management

The management of the DCP program can be categorized into field and office functions as follows:

Field -
- Training
- Deployment
- Operation and Maintenance
- Upgrades

Office -
- Co-operative Agreements
- Network Planning
- Training
- Platform Documentation
- Maintainance of Platform files at Direct Readout Ground Station (DRGS) and National Environment Satellite Service (NESS)
- Data Acquisition and Archival

4.7.1 Field

4.7.1.1 Training

A mechanism for determining training needs should be instituted. Current needs were identified in this report in Section 4.6 but because of the changing nature of this technology, this list should be updated annually. Because of similar requirements across the country, the training should be coordinated nationally.

4.7.1.2 Deployment

Planning is the key to a successful deployment program. Once the sites have been identified, the technicians responsible for the stations should begin developing a plan keeping these factors in mind:

- station location (remote or normal access)
- availability of installation equipment
- joint installations with other technicians
- data requirements
- availability of DCPs and associated equipment
- time frame for installation
- scheduling of transportation to remote stations
- availability of transmission time slots
- platform documentation
- notification of users
- follow-up report

4.7.1.3 Operation and Maintenance

It is recommended that the operation of the network be monitored daily, during normal working days.

On a daily basis, a summary of maximum and minimum signal quality parameters should be available for each DCP. One individual should be assigned on a rotating basis to examine these parameters and report any concerns to the appropriate technician. It is also important that station parameters such as stage be monitored so that field programs can be adjusted to account for special conditions. Alarms are a feature of the SUTRON software that could be used for this purpose.

An up-to-date listing of all platforms and associated information is essential.

4.7.1.4 Upgrades

The existing Data Collection Platform instrumentation may require upgrading due to new technology, response to field problems, i.e. grounding of antennas, and surge protectors for the transmitters or deterioration of crystals.

An upgrade program is similar to a deployment program in that good planning is required. The number of stations to be upgraded will determine the extent of the planning. An added concern is the availability of personnel trained in the installation and operation of the new equipment.

4.7.2 Office

4.7.2.1 Co-operative Agreements

The lack of a policy on the operation of real time equipment for co-operating agencies is a continuing source of frustration, both for the technician operating the equipment and the agency requiring the data. Uncertainty on whether a special trip is required, who will absorb the cost and the priority level for completing the trip surface every time a site malfunctions, particulary if it is a remote location, since without a policy, our organization inevitably absorbs the cost of a trip into the site to

fix the problem. It is important that a policy be formulated and implemented in the near future to avoid this problem.

4.7.2.2 Network Planning

There is a need to examine the real time network on a periodic basis and adjust it accordingly. At present there is no procedure in place to do this. Requests for new sites received from interested organizations are processed and actioned individually with very little if any consideration for the overall network. An attempt was made in this report to identify known needs for real time data at specific sites and to identify redundant sites.

This excercise should be repeated annually with the aid of guidelines to choose or reject sites. The last review was done through discussions with the field personnel, discussions with Sask Water and a basic knowledge of the network.

It should be kept in mind that rapid changes cannot be easily accommodated in the field program, therefore, advance planning is especially important.

4.7.2.3 Training

Training in the use of computer programs to compute hydrometric record using DCP data will be required once the programs are available on the computer systems. At present no tested acceptable software is available therefore it is difficult to estimate training requirements.

Training in the maintenance of the platform files at NESS and at each receive site will also be required.

4.7.2.4 Platform Documentation

Each technician is responsible for completing a Platform Directory File (PDF) sheet for each DCP installed or changed. These sheets should be sent to the Data Control Section as soon as possible after changes are made.

4.7.2.5 Maintenance of Platform Files

It is likely that the Platform Files will be maintained by the Data Control Section. Changes will be made as they are received from the technical staff.

A new interface to the National Environmental Satellite Service (NESS) was implemented in September, 1989. This system called DAPS (Data Communication Services Automated Processing System) is used to make any changes to the DCP platform files at NESS.

4.7.2.6 Data Acquisition and Archiving

Until programs are available for computation of the data, it is not worthwhile archiving DCP data on the regional computer. The large quantity of data collected but not used would overtax system resources such as disk space. If a need for the data develops, archival procedures should be re-evaluated.

A daily retrieval of the raw data file and a special retrieval from each of the receive sites done at 07:00 serves the present day to day needs.

5 PROPOSED CHANGES TO THE SASKATCHEWAN TELEMETRY NETWORK

Data collection platforms are expensive, specialized items, therefore, they should only be installed at sites where there are well defined needs. At the present time, however, there is an over supply in Saskatchewan mainly due to an over-zealous deployment under the National DCP Program. Some of these extra units could be used to improve monitoring and operations in non-remote areas.

The last five or six years have been characterized by very low flows over much of the Prairies. During years such as these, there is a greater demand for data for water management purposes but essentially none for flood forecasting. There is a tendency to be lulled into an attitude of nonchalance on the part of both Sask Water who must carry out the forecasting and WSC who must deliver much of the data. It is suggested that we re-assess the real-time network with this in mind and use these relatively quiet times to put the infrastructure in place to handle high flow years. This does not necessarily mean that DCPs be deployed and activated at a large number of sites, but important sites should be identified annually and an inventory of available platforms and auxiliary equipment such as memomarks, antennae, batteries and programming units prepared prior to runoff.

It is also suggested that a reasonable number of platforms be installed and operated at index stations in several basins in the province. The reason for this is two-fold: a) it would allow an assessment of the effectiveness of using DCPs for monitoring the onset of runoff and summer rainstorm response in basins located long distances away from the office and b) it would allow more of the technical staff the opportunity to keep abreast of the operating procedures for this equipment on an ongoing basis as opposed to learning it in the midst of a flood. At the same time, we should be investigating inexpensive sensors for monitoring air temperature and precipitation. The value of the index sites would increase significantly with the addition of these sensors.

There are areas of the province such as the international basins that could benefit in the area of reduction of field trips if DCPs were installed in conjunction with good quality instream controls: there is not a lot to be gained if a station requires frequent discharge measurements. There will be a pronounced growth in the demand for more information for the Souris basin, because of the need for better water management due to the construction of the Alameda and Rafferty projects.

The following list of stations is the first draft of a proposed dynamic list of station where the installation of telemetry equipment would be beneficial. The list should be discussed with Sask Water and the Canada - Saskatchewan Flood Forecasting Committee for their input. A map of Saskatchewan of the proposed telemetry network is shown on Figure 1.

a) Index Stations

Souris basin
- Gainsborough or Lightning Creek (suggest Lightning Creek near Carnduff
- Gibson Creek near Radville (can also be used for flood forecasting)
  Note: A DCP has been installed at this site.

Wood River/East Poplar basins
- Mcdonald Creek near McCord or East Poplar River above Cookson Reservoir

Frenchman/Battle/Lodge basins
- Denniel Creek and/or Belanger Creek Diversion

Maple Creek area
- Gap Creek, Bear Creek or Downie Lake Inflow Canal (suggest Downie Lake Inflow Canal)

Notukeu/Swift Current Creek basins
- Notukeu Creek above Admiral Reservoir or Swift Current Creek below Rock Creek

Mid-Western area
- Muddy Lake Inflow near Revenue or Opuntia Lake West Inflow

Meadow Lake/Beaver River basins
- Beaver River near Dorintosh (could also be used for flood forecasting)
- Englishman River near Spruce Lake

Quill Lakes basin
- Birch Creek near Elfros or Magnusson Creek near Wynyard

Red Deer River basin
- Duck Creek near Kelvington

Others? Carrot River basin? Brightwater Creek? Moose Jaw River?

b) Flood Forecasting

Souris River basin
- Radio telemetry has been removed from Long Creek at the Western Crossing. Information from this station and Boundary Reservoir is critical during floods.

Moose Jaw River basin
- Moose Jaw River near Rouleau

Qu'Appelle River basin
- Last Mountain Lake at Rowan's Ravine (could also be used for water management)
- Moose Jaw River near Burdick
- Qu'Appelle River above Buffalo Pound Lake
- Qu'Appelle River at Hyde
- Qu'Appelle River below Loon Creek
- Qu'Appelle River below Moose Jaw River

Wascana Creek basin
- Wascana Creek near Sedley

Wood River basin
- Wood River near LaFleche or Notukeu Creek near Vanguard

Assiniboine River basin
- Whitesand River near Canora

Carrot River basin
- Carrot River near Armley

Red Deer River basin
- Red Deer River near Steen

Swan River basin
- Swan River near Norquay

Saskatchewan River basin
- Torch River near Love

c) Water Management

- South Saskatchewan River at St. Louis
- Buffalo Pound Lake at Pumping Station
- Cookson Reservoir

GLOSSARY

Bristol Data Collection Platform
- a transmitting device manufactured by Bristol Aerospace which is used by the Water Survey of Canada to transmit environmental information such as water levels via satellite.

Bristol Hydromet Data Collection Platform
- a particular model of platform manufactured by Bristol Aerospace. This model is capable of transmitting coded data which can be utilized by Water Survey of Canada computer programs in operation in 1988-89. Two versions of this model were manufactured.

Direct Readout Ground Station
- a land based satellite receive site composed of a satellite dish with controller, true timer, demodulation hardware, a computer and associated software. The three sites used by the Water Survey of Canada (Downsview, Gatineau and Vancouver) were provided by Sutron Corporation. A Micro VAX II computer at each site communicates with WSC offices by Telecom Canada's X-25 service and Digital's DECnet software. Each site is capable of handling 1000 DCPs.

Fixed Frequency DCP
- a data collection platform with the transmitter crystal set to transmit on one specific channel. The transmitter cannot be changed to another channel except by the installation of a new transmitter crystal. The cost to upgrade to a frequency agile transmitter is in excess of $2600.

Frequency Agile DCP
- a data collection platform with a transmitter that is programmable. The DCP can transmit on any of the available GOES channels. The first frequency agile DCP received by WRB Saskatchewan was serial number BA-EN-450.

Memomark
- an encoding device manufactured by Leopold & Stevens which converts water levels (or other parameters) into a format suitable for a data collection platform. The model in common use in 1989 by the Water Survey of Canada is the Memomark III in conjunction with a pulse generator.

Telemark

- an encoding device manufactured by Leopold and Stevens capable of transmitting a parameter such as water level via telephone. Recent models (late 1980s) can also be used for satellite telemetry. All telemarks in Saskatchewan are of the type that require manual telephone interrogation by counting a sequence of audible beeps generated by the telemark.

Solar Panel

- a photo-sensitive device which is capable of producing an electrical current from solar radiation. These devices are commonly used in remote sites by the Water Survey of Canada to maintain the electrical charge of batteries used to power water level sensing and transmitting equipment.

SUTRON

- Sutron Corporation manufactures a full line of instrumentation for use in the collection, transmission, processing and reception of sensor data via telemetry systems.

LIST OF ABBREVIATIONS

ADOE	Alberta Department of the Environment
AES	Atmospheric Environment Service
CDP	Career Development Program
DCP	Data Collection Platform
DAPS	Data Communication Services Automated Processing System
DRGS	Direct Readout Ground Station
GOES	Geostationary Orbiting Environmental Satellite
MCF	Master Configuration File
MWRB	Manitoba Water Resources Branch
NCPC	Northern Canada Power Commission
NESDIS	National Environmental Satellite Data and Information Service
NESS	National Environmental Satellite Service
NWS	National Weather Service
PDF	Platform Directory File
PFRA	Prairie Farm Rehabilitation Administration
PPWB	Prairie Provinces Water Board
SPC	Saskatchewan Power Corporation
Sask Water	Saskatchewan Water Corporation
WRB	Water Resources Branch
WSC	Water Survey of Canada
USGS	United States Geological Survey

TABLE 1

DCP Deployment, Saskatchewan, March 31, 1989

WSC NO	NAME	NESS ID	TIME	CH	A/D/P	DCP S/N	ENCODER MODEL	ENCODER S/N
National Program								
07LC002	Chipman River above Black Lake	4815E3DA	0052	09	D	83-11-057	Memomark III	110933-83
06CE001	Foster River above Churchill River	4558170C	0230	19	A	84-03-073	Memomark III	110930-83
07MC003	Lake Athabasca near Crackingstone Point	48150028	0028	09	A	83-09-034	Memomark III	111379-84
07LE003	Grease River below Fontaine Lake	4815D640	0049	09	A	83-11-055	Memomark III	110934-83
07LC003	Porcupine River at Outlet Grove Lake	455819DE	0231	19	A	84-03-074	Memomark III	110932-83
07QC002	Tazin Lake near Outlet	4815F0AC	0053	09	A	83-11-058	Memomark III	110935-83
06DB003	Thyme Hill River below MacKenzie Lake	4814F256	0027	09	A	83-09-030	Memomark III	111380-84
06DC001	Wathaman River below Wathaman Lake	4814E120	0024	09	A	BN-EN-477	Memomark III	110931-83
06DA004	Geikie River below Wheeler River	481825A2	0152	09	A	BA-EN-410	Memomark III	113663-84, 113143-84
07MB001	MacFarlane River at Outlet of Davy Lake	480933B0	0048	14	A	BA-EN-388	Memomark III	113678-84, 113151-84
07MA003	Douglas River near Cluff Lake	481836D4	0153	09	A	BA-EN-379	Memomark III	113675-84, 113148-84
07MA004	William River above Carswell River	48094520	0049	14	D	BA-EN-433	Memomark III	113677-84, 113150-84
07LE004	Otherside River at Outlet of Mercredi Lake	48095656	0050	14	A	BA-EN-384	Memomark III	113676-84, 113149-84
06DA001	Wollaston Lake at Ross Channel	48184044	0154	09	A	BA-EN-409	Memomark III	113664-84, 113144-84
06EA007	Pagato River at Outlet of Pagato Lake	48185332	0157	09	A	BA-EN-408	Memomark III	113665-84,
06DA005	Wheeler River below Russell Lake	480A8730	0109	14	A	BA-EN-583	Memomark III	116875-85, 116854-85
07LB002	Waterfound River below Unknown Lake	480A9446	0110	14	A	BA-EN-580	Memomark III	117520-85,
07LE002	Fond du lac River at Outlet of Black Lake	480AA1DC	0112	14	D	BA-EN-578	Memomark III	117521-85
07LD002	Cree River at Outlet of Wapata Lake	480AB2AA	0113	14	A	BA-EN-584	Memomark III	116876-85
07LD003	Pipestone River below Rotariu Lake	480AC43A	0114	14	A	BA-EN-450	Memomark III	116872-85
06AG002	Dore River near the Mouth	480290E0	0214	22	D	BA-EN-609	Memomark III	
06BB005	Canoe River near Beauval	480AE2D6	0116	14	D	BA-EN-610	Memomark III	
06BA002	Dillon River below Dillon Lake	480AF1A0	0117	14	D	BA-EN-607	Memomark III	115187-85, 115306-85
07LD001	Cree Lake at Cable Bay	480AD74C	0115	14	D	BA-EN-507	Memomark III	116877-85
07CD007	Descharme River below Dupre Lake	4802A57A	0215	22	A	BA-EN-577	Memomark III	
07CD006	Clearwater River at Outlet of Lloyd Lake	4802B60C	0216	22	D	BA-EN-581	Memomark III	
06BD001	Haultain River above Norbert River	480D8504	0155	05	A	BA-EN-582	Memomark III	
06BC001	Mudjatik River near Forcier Lake	4802C09C	0217	22	A	BA-EN-612	Memomark III	
06BB004	Keeley River at Outlet of Keeley Lake	4802D3EA	0218	22	A	BA-EN-611	Memomark III	
06EA002	Churchill River at Sandy Bay	480D9672	0156	05	A	BA-EN-608	Memomark III	117522-85

Sask Water Program

05JM006	Crooked Lake near Grayson	4551AC0C	0225	19	A	82-01-001	Memomark III	110499-83, 110394-83
05HF003	Lake Diefenbaker at Gardiner Dam	45413EF0	0021	13	A	BA-EN-497	Memomark III	110503-83, 110393-83
05EF001	North Sask River near Deer Creek	4551BF7A	0227	19	A	82-01-002	Memomark III	110501-83, 110392-83
05JK002	Qu'Appelle River below Craven Dam	4551B1A8	0226	19	A	BA-EN-506	Memomark III	110500-83, 110391-83
05CK004	Red Deer River near Bindloss	45608E6A	0235	13	D	82-03-005	Memomark III	110504-83, 110395-83
05JM001	Qu'Appelle River near Welby	4551A2DE	0224	19	A	82-03-003	Memomark III	110502-83, 110390-83
06CD002	Churchill River above Otter Rapids (SPC)	4811F596	0018	03		BA-EN-493	Memomark III	117468-85
06DD002	Reindeer River above Devil Rapids (SPC)	4812021C	0019	03	A	BA-EN-499	Memomark III	116878-85,
06EA011	Churchill River above Wintego Rapids (SPC)	4811D37A	0016	03	A	BA-EN-498	Memomark III	115665-85, 117217-85
06EA010	Churchill River at Maple Leaf Rapids (SPC)	4811E6E0	0017	03	A	BA-EN-496	Memomark III	116855-85
07QC006	Tazin River above Tazin Lake (SPC)	4802F506	0229	22	A	BA-EN-723	Memomark III	120055-86
07QC005	Abitau River above Cuming Lake (SPC)	4802E670	0219	22	A	BA-EN-724	Memomark III	121136-86

Water Survey Program

11AB089	Altawan Reservoir near Govenlock	45519744	0222	19	A	81-02-026	Memomark III	113679-84, 113152-84
11AB027	Battle Creek at International Boundary	45580AA8	0229	19	A	82-06-011	Memomark III	57943
11AB009	Middle Creek near Sask Boundary	45519996	0223	19	A	81-03-030	Memomark III	113673-84, 113146-84
05ND004	Moose Mountain Creek Near Oxbow	45416E8C	0023	19	A	84-03-071	Memomark III	110498-83, 110389-83
05NB009	Souris River Near Roche Percee	45417328	0024	19	A	84-03-072	Memomark III	110497-83, 110388-83
11AB117	Battle Creek at Alberta Boundary	4558047A	0228	19	A	82-06-012	Memomark III	113672-84, 113145-84
11AB082	Lodge Creek near Alberta Boundary	4560A886	0229	13	A	79-10-005	Memomark III	
05FE004	Battle River near the Saskatchewan Boundary	45518432	0220	19	A	BA-EN-501	Memomark III	117461-85
05MD004	Assiniboine River near Kamsack	480B03DE	0118	14	A	BA-EN-741	Memomark III	
05NA005	Gibson Creek near Radville	481875DE	0159	09	A	BA-EN-743	Memomark III	
05NA003	Long Creek at Western Crossing	4818855A	0202	09	A	BA-EN-731	Memomark III	
	Spare Time Slot	4806D6D0	0001	14				
	Spare Time Slot	4806E34A	0002	14				
	Spare Time Slot	480A77B4	0108	14				
	Spare Time Slot	45518AE0	0221	19				
	Spare Time Slot	454190DA	0028	19				
	Spare Time Slot	480963CC	0051	14		Spare Time Slot		480B10A8 011
	Spare Time Slot	480B2532	0120	14				
	Spare Time Slot	4818962C	0203	09	A	Shelter Testing		
	Spare Time Slot	4802E670	0219	22				
	Spare Time Slot	4802F506	0229	22				

[1] A = Active
D = Deactive
P = Proposed

Figure 1

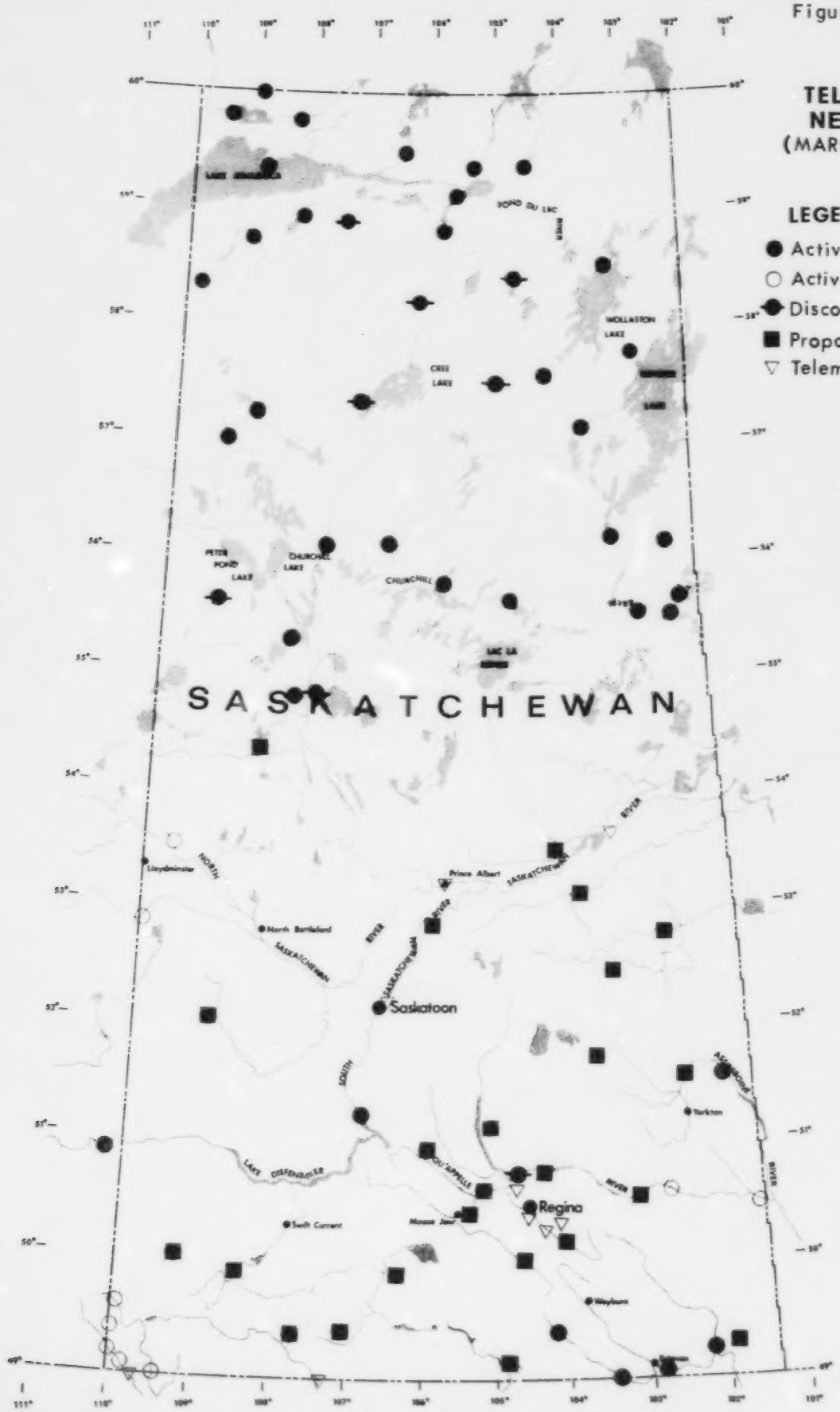
TELEMETRY
NETWORK
(MARCH 31, 1989)
LEGEND
Active - New Style DCP
Active - Old Style DCP
Discontinue
Proposed - Tentative
Telemarks
SASKATCHEWAN
Saskatoon
Regina
Yorkton
Swift Current
Moose Jaw
Weyburn
North Battleford
Prince Albert
Lloydminster
LAKE DIEFENBAKER
WOLLASTON LAKE
CHURCHILL
PETER POND LAKE
CREE LAKE
LAC LA RONGE

Figure 2

TELEMETRY NETWORK
(March 31, 1931)

LEGEND

- ● DCP - Hydromet
- ○ DCP - Old style
- ▽ Telemark